New Perspectives on Quantum Field Theory with Boundaries, Impurities, and Defects

Monday, 31 July 2023 - Friday, 11 August 2023

Albano Building 3

Scientific Programme

Week 1

Monday, 31 July
10:00 Coffee at Nordita
1:25 - 1:30: Welcome
1:30 - 2:30: Tonni
3:00 - 4:00: Tseytlin

Tuesday, 1 August
10:00 Coffee at Nordita
1:30 - 2:30: Konechny
3:00 - 4:00: Helfenberger
6:30: Welcome reception

Wednesday, 2 August
10:00 Coffee at Nordita
1:30 - 2:30: Kiritsis
3:00 - 4:00: Runkel

Thursday, 3 August
10:00 Coffee at Nordita
10:30: Informal discussion about Wilson lines led by Puletti (6th floor)
1:30 - 2:30: Brennan
3:00 - 4:00 Frau
6:30 Dinner at Fotografiska (Stadsgårdshamnen 22)
https://www.fotografiska.com/sto/en/besok/

Friday, 4 August
10:00 Coffee at Nordita
10:30: Informal discussion on categorical approaches to physics of defects led by Runkel (6th floor)
1:30 - 2:30: Russo
3:00 - 4:00: Parisen Toldin

Week 2

Monday, 7 August
10:00 Coffee at Nordita
1:25 - 1:30: Welcome
1:30 - 2:30: Behan
3:00 - 4:00: Chernodub

Tuesday, 8 August
10:00 Coffee at Nordita
10:30 - 12:00 Short talks:
Chalabi:Weyl Anomalies of Conformal Boundaries and Defects.
Ge: Boundary induced dynamical phase transition via inhomogeneous quenches
Rodgers: Holographic Wilson lines from matter on spheres
Piazzalunga: 4G Networks
Yan: Topological lines on the lattice

1:30 - 2:30: Stefanski
3:00 - 4:00: Komargodski

Wednesday, 9 August
10:00 Coffee at Nordita
1:30 - 2:30: Harribey
3:00 - 4:00: Metlitski

Thursday, 10 August
10:00 Coffee at Nordita
10:30: Informal discussion on boundary universality in O(N) models led by Metlitski (6th floor)
1:30 - 2:30: Di Pietro
3:00 - 4:00 Stergiou
6:30: Dinner at Artilleriet (Artillerigatan 13)

Friday, 11 August
10:00 Coffee at Nordita
1:30 - 2:30: Moroz

Connor Behan
Title: Analytic and numerical bootstrap of the long-range Ising model
Abstract: The critical long-range Ising model is a set of non-supersymmetric conformal field theories indexed by a continuous parameter. A number of properties make it an ideal starting point for exploring the space of nonlocal CFTs. It can be realized as a defect for a free field in two different ways, each of which exhibit a number of non-renormalization theorems. I will explain how this can be used to reduce the number of diagrammatic calculations and compute several new perturbative critical exponents along the way. Then I will explain how a technique originally developed for BCFT can be used to study the long-range Ising model with the numerical bootstrap. This will lead to a series of "kinks" which smoothly match onto perturbative results and yield new predictions in the non-perturbative regime.

T. D. Brennan
Title: Anomalies of Discrete 1-Form Symmetries in QCD-like Theories
Abstract: In this talk we will discuss a new class of non-perturbative anomalies of discrete 1-form global symmetries in 4D QCD-like theories. This generalizes the techniques developed by Wang-Wen-Witten to more general theories that allow for discrete 1-form global symmetries including chiral gauge theories. We will demonstrate several new anomalies and comment on their implication on symmetric mass generation in 3+1D.

Maxim Chernodub
Title: (Non-)Abelian Casimir effects and boundary states in confining theories: results of first-principle simulations
Abstract: We review the results of Monte Carlo lattice simulations on (non-)Abelian Casimir effects in confining gauge theories, covering topics from 2+1d compact electrodynamics to Yang-Mills theories in 3+1 dimensions. The effects of (chromo)metallic mirrors on phase structure and mass gap generation are discussed. For the first time, we reveal an edge mode in Yang-Mills theory, a "glueton", localized on a (chromo-conducting) boundary. Analogies with surface electron-hole excitons in semiconductors and boundary states of fractional vortices in multicomponent superconducting condensates are highlighted.

Lorenzo Di Pietro
Title: BCFT One-Point Functions of Coulomb Branch Operators
Abstract: I will discuss a method to compute the one-point functions of chiral primary operators in 4d N=2 SCFTs with ½ BPS boundary conditions. A SUSY identity relates these correlators to derivatives of the hemisphere partition function, adapting to the boundary case the known method to compute chiral/antichiral two-point functions. This requires to take appropriate care of certain boundary terms in the Ward identities. I will then show the localization formulas that can be used to derive exact results for these one-point functions. As an explicit example, I will focus on the case of super Maxwell theory coupled to a 3d N=2 SCFT on the boundary.

Marialuisa Frau
Title: Strong coupling results in N=2 gauge theories
Abstract: We will discuss recent developments in the study of correlation functions of chiral scalar operators and Wilson loops in four-dimensional N=2 quiver gauge theories. Using supersymmetric localization, it is possible to map the computation of these correlators to an interacting matrix model and obtain expressions that are valid for any value of the ’t Hooft coupling in the planar limit of the theory. In particular, we will focus on the strong-coupling regime, where these expressions allow us to compute the leading and subleading orders behavior of the observables in an analytic way.

Sabine Harribey
Title: Boundaries and Interfaces with Localized Cubic Interactions in the O(N) Model
Abstract: In this talk, I will present a new approach to boundaries and interfaces in the O(N) model where we add certain localized cubic interactions. These operators are nearly marginal when the bulk is four dimensional and they explicitly break the O(N) symmetry of the bulk theory down to O(N-1). The one-loop beta functions of the cubic couplings are then modified by the quartic bulk interactions. I will present the RG analysis for both the interface and the boundary cases. In the interface case, for sufficiently large N, we find stable IR fixed points with purely imaginary cubic couplings. In the boundary case, we find real fixed points for all N. I will also review theories of M pairs of symplectic fermions and one real scalar. The beta functions for these theories are related to those in the O(N) model via the replacement of N by 1-2M.

Elizabeth Helfenberger
Title: Line defects in fermionic CFTs
Abstract: In this talk I will discuss line defects in the fermionic CFTs in the Gross-Neveu-Yukawa universality class in dimensions between 2 and 4. These CFTs may be described as the IR fixed points of the Gross-Neveu-Yukawa (GNY) model in d=4-\epsilon, or as the UV fixed points of the Gross-Neveu (GN) model, which can be studied using the large N expansion. These models admit natural line defects obtained by integrating over a line either the scalar field in the GNY description, or the fermion bilinear operator in the GN description. We compute the beta function for the defect RG flow using both the epsilon expansion and the large N approach, and find IR stable fixed points for the defect coupling, thus providing evidence for a non-trivial IR DCFT. We also compute some of the DCFT observables at the fixed point, and check that the g-function associated with the circular defect is consistent with the g-theorem for the defect RG flow.

Elias Kiritsis
Title: Holographic interfaces, QFTs on AdS and Wormholes

Zohar Komargodski
Title: 't Hooft lines in 3+1 Dimensions

Anatoly Konechny
Title: RG boundaries and Cardy's variational ansatz for multiple perturbations
Abstract: We will consider perturbations of 2D CFTs by multiple relevant operators. The massive phases of such perturbations can be labeled by conformal boundary conditions. Cardy's variational ansatz approximates the vacuum state of the perturbed theory by a smeared conformal boundary state. In this talk we will discuss the limitations and propose generalisations of this ansatz using both analytic and numerical insights based on TCSA. In particular we analyse the stability of Cardy's ansatz states with respect to boundary relevant perturbations using bulk-boundary OPE coefficients. We show that certain transitions between the massive phases arise from a pair of boundary RG flows. The RG flows start from the conformal boundary on the transition surface and end on those that lie on the two sides of it. As an example we work out the details of the phase diagram for the Ising field theory and for the tricritical Ising model perturbed by the leading thermal and magnetic fields. Based on arXiv:2306.13719.

Max Metlitski
Title: Boundary and plane defect criticality in the 3d O(N) model

Sergej Moroz
Title: Higgs phase and SPT order
Abstract: After a brief introduction in the field of lattice gauge theories, I will discuss a surprising phenomenon emerging from the interplay of dynamical gauge fields and quantum matter. I will explain how in the Ising gauge theory the Higgs phase, where matter condenses, exhibits symmetry-protected topological order. In the presence of a symmetry-preserving boundary the ground state in this phase is degenerate which allows to distinguish sharply the confined and Higgs regimes.

Francois Parisen Toldin
Title: Advances in the boundary O(N) universality class
Abstract: In critical phenomena, the presence of surfaces or more general boundaries gives rise to rich phase diagrams and interesting phenomena, such as critical adsorption and critical Casimir forces. Despite being a mature subject, boundary critical phenomena have recently attracted a renewed attention, driven in particular by the discovery of unexpected behavior in various quantum spin models, and by progresses in conformal field theory. In this context, a reexamination of the simplest model of boundary criticality -- the three-dimensional O(N) model bounded by a bidimensional surface -- has led to the discovery of a hitherto overlooked boundary phase, the so-called extraordinary-log phase. In this seminar I will review these recent advances, focusing in particular on results of numerical simulations, and discuss future research directions.

Ingo Runkel
Title: Non-invertible symmetries and their gaugings in low-dimensional field theory
Abstract: The study of topological defects in quantum field theory has seen a wealth of activity recently leading to many interesting insights, for example the explicit realisation of non-invertible topological defects in higher dimensional QFTs via the gauging of higher form symmetries. In this talk, I would like to focus on two-dimensional examples, where such defects and their properties have been investigated for some time already. I would like to show some of the structural insights into 2d CFT one can gain from topological defects and from their gauging. In this way, the well-understood two-dimensional case might serves as a source of ideas and as a test-case for higher dimensional constructions.

Jorge Russo

Title: Defects in Scalar Field Theories

Bogdan Stefanski
Title: Low-supersymmetry exact D-instanton corrections from String Field Theory

Andreas Stergiou
Title: Fixed Points and Line Defects in the ε Expansion
Abstract: The ε expansion was invented more than 50 years ago and has been used extensively ever since to study aspects of renormalisation group flows and critical phenomena. In the first part of this talk we will discuss the structure of the ε expansion and the fixed points that can be obtained within it, focusing mostly on scalar theories in 4−ε dimensions. In the second part we will consider line defect deformations of various ε expansion fixed points and discuss aspects of the infrared defect conformal field theories that arise.

Erik Tonni
Title: Entanglement entropies for Lifshitz fermionic fields at finite density
Abstract: The entanglement entropies of an interval for the free fermionic spinless Schroedinger field theory at finite density and zero temperature are investigated. The interval is either on the line or at the beginning of the half line, when either Neumann or Dirichlet boundary conditions are imposed at the origin. We show that the entanglement entropies are finite functions of a dimensionless parameter proportional to the area of the rectangular region in the phase space identified by the Fermi momentum and the length of the interval. For the interval on the line, the entanglement entropy is a monotonically increasing function. Instead, for the interval on the half line, it displays an oscillatory behaviour related to the Friedel oscillations of the mean particle density at the entangling point. By employing the properties of the prolate spheroidal wave functions or the expansions of the tau functions of the kernels occurring in the spectral problems, determined by the two point function, we find analytic expressions for the expansions of the entanglement entropies in the asymptotic regimes of small and large area of the rectangular phase space region. Extending our analysis to a class of free fermionic Lifshitz models, we find that the parity of the Lifshitz exponent determines the properties of the bipartite entanglement.

Arkady Tseytlin
Title: Wilson Loop at large N and quantum M2-brane
Abstract: I will review recent work with Simone Giombi in 2303.15207 on reproducing the localization prediction for the prefactor in the expectation value of 1/2 BPS Wilson loop in 3d ABJM theory from 1-loop computation in supermembrane theory in AdS4 x S7/Z_k background. I will also mention some generalizations.